INLAND FISHERIES OF INDO-PACIFIC COUNTRIES

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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PREPARATION OF THIS DOCUMENT

This is the second edition of the overview of the status of inland fisheries of thirteen individual countries of the Indo-Pacific region. These have been updated since the previous publication (FAO Fisheries Circular No. 794, 1986) by Xiangke Lu, Inland Water Resources and Aquaculture Service, FAO. The document does not include all countries of the region. Compared to the first edition published in 1986, only 13 countries submitted the relevant information. There are approximately 36 countries in Asia and the Pacific with inland fisheries activities. We hope that the future edition will cover many more countries than the present one. For this purpose, we solicit your collaboration. Please contact the Chief, Inland Waters Resources and Aquaculture Service (FIRI) of the Fishery Resources and Environment Division, FAO, 00100 Rome, Italy with your suggestions for the next edition.

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The FAO Fisheries Circular is a vehicle for distribution of short or ephemeral notes, lists, etc., including provisional versions of documents to be issued later in other series.

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ABSTRACT

This document contains updated reviews of the status of inland fisheries for the following countries of the Indo-Pacific region: Australia, Bangladesh, Cambodia, China, Malaysia, Myanmar, Nepal, New Zealand, Papua New Guinea, Philippines, Sri Lanka, Thailand and Viet Nam. The information provided for each country includes: area, population, total catch, physical geography, climate, hydrology with information on rivers, lakes and reservoirs, land and water use, inland fishery yield/production for the last 10 year period, state of the fishery with information on the yield, factors influencing the yield, and inland fishery development forecast. The document is to be updated and expanded, as more information becomes available.

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AUSTRALIA

1. AREA: 7 682 300 km^2.

2. POPULATION: 16 807 000 (1989) Density: 2.2 persons/km^2

3. TOTAL CATCH: 227 300 t* Inland fishery: 4 307 t* (1.89 %)

* FAO Fishery Statistics, 1991.

4. PHYSICAL GEOGRAPHY

Australia, including Tasmania, has a coastline of 36 735 km. Continental Australia extends for about 4 000 km from east to west, and 3 180 km from north to south. Tasmania, separated from the mainland by 230 km, is about 328 km (N-S) and 314 km (W-E). The continent is divided into three main topographical areas: (i) the Eastern Highlands, extending about 2 250 km from northern Queensland parallel to the east coast of western Victoria. Structurally, Tasmania is an extension of the Eastern Highlands. (ii) The Central Lowlands extend from the Gulf of Carpentaria in the north to the Great Australian Bight in the south. (iii) The Western Plateau, which covers more than half the continent, includes Western Australia, half of South Australia, the Northern Territory and parts of New South Wales and Queensland.

5. CLIMATE

In general, the climate is warm to hot and dry. Tropical Australia has two seasons: wet and dry, with heaviest rainfalls between December and April, and the dry season extends from April to August. Only a third of the continent, following the north, east and south-east coast and extending 300-600 km inland receives an average rainfall of more than 500 mm per year. The highest rainfall, averaging 4 500 mm a year occurs on the north coast of Queensland. Much of Australia's interior which is a vast arid region receives little rain. Highest temperatures over much of the inland territory may reach 40°C in January.

6. HYDROLOGY

Average annual runoff for the continent is only 45 mm and less than 5 percent of the continent has an average annual runoff of more than 250 mm. Ground water is an important substitute for surface water over much of the arid interior, with the Great Artesian Basin (underlies 22 percent of the continent) providing the only reliable continuous supply of water for stock and domestic purposes.

6.1 Rivers

Most of Australia experiences large seasonal and annual variations in stream flow. Streams are either seasonal or ephemeral, most perennial streams are confined to the relatively well-watered fringes in the east, southeast and southwest and the Murray-Darling system of the continent.

6.2 Lakes

The only permanent and extensive natural lakeland is in the highlands of Tasmania.

6.3 Reservoirs

There are presently 81 large dams with gross reservoir capacities in excess of 100 gigalitres(GL) each, and a combined storage of 76 661 GL. As well, there are innumerable small reservoirs and farm dams. Depending on location, the purposes of these storages include hydro-electricity, industrial(including mining) supply, irrigation, flood control, rural(stock and domestic) and urban supplies. Of a total commitment of 14 600 GL, seventy percent is allocated for irrigation, twenty-one percent for urban and industrial use, and nine percent for rural use.

7. LAND AND WATER USE

Australia is rich in minerals, oil and natural gas. Sixty-five percent of the continent is taken up by farms, about three percent of farm land is used for crops, 5.5 percent for sown pasture, the remainder is largely semi-arid grazing land. Graze lands together with hay and fodder crops are the basis of livestock industries which have long been the mainstay of Australian agriculture. Only one quarter of the population is rural based. Recreation is a major use of most inland waters.

8. FISHERY YIELD/PRODUCTION

Nominal yield from inland waters of Australia(1982-1991)
(in tons)

1982	1983	1984	1985	1986
3 459	2 954	3 058	2 079	2 050

1987	1988	1989	1990	1991
2 200	2 427	3 159	3 260	4 307

All data for Australia refer to a split-year (1 July to 30 June) shown under the calendar year in which the split-year ends.

These data include values for Barramundi (Lates calcarifer) which is caught in estuarine and in-shore marine waters. However, this catadromous species spends most of its life in freshwater, where it forms an important recreational fishery. Thus, it is

considered an important element of the inland fishery, the commercial harvest of which is better facilitated in marine, rather than fresh water.

By the same token, these data do not include values for Rainbow trout (Oncorhynchus mykiss) which has recently been cage-cultured in commercial quantities because that production occurs almost completely in estuarine waters.

The values given are underestimates for some years because of missing data from some of the relevant authorities. No estimate is presently available of the amount of underestimation. Nor do these data contain values for the recreational fishery which, in the case of Barramundi (Lates calcarifer) fishery of the Northern Territory, is considered to equal the commercial fishery in economic benefit if not in outright catch.

9. STATE OF THE FISHERY

9.1 Yield

The most significant food species in the inland fishery is Lates calcarifer, with a production, in 1989/90, of 1 350 t. This species is harvested from wild stocks in the tropical north of the country. More than half the inland fishery yield comes from the waters of the Murray-Darling river system, but the bulk of the harvest, comprising Cyprinus carpio and the native Nematalosa erebi (combined catch: 10 674 t. 1989/90), is not for human comsumption. Less abundant species, which tend to be marketed as specialty product as does barramundi (L. calcarifer) include the native Golden perch (Macquaria ambigua), Murray cod (Maccullochella peeli), and the crayfish Yabby (Cherax destructor). Tilapias are considered to be noxious fish species in most states of Australia and their culture is prohibited.

9.2 Factors influencing yield

The majority of dams in which fishing activities are permitted are managed for recreational fisheries, for which no yield data are presently available. Many hatcheries exist to produce fingerlings of native species for this fishery. The only species commercially fished in impoundments are the various eel species (Anguilla spp.).

With the recent improvements in sea-cage technology, the culture of salmonids for food, which used to be based on small inland hatcheries, has largely been transferred to estuarine waters. Inland hatcheries, however, still supply salmonid fingerlings for the recreational fishery.

Aquaculture production of crayfish (Cherax, Euastacus) and aquarium fishes is presently at too low a volume for reliable statistical collation.

9.3 Forecast

Commercial inland fishing is unlikely to increase dramatically in the future; however, farming of freshwater crustaceans is likely to expand, and also further development of farms producing aquarium fish.

BANGLADESH

1. AREA: 143 999 km^2

2. POPULATION: 108 800 000 Density: 756 persons/km^2

3. TOTAL CATCH: 892 700 t Inland fish: 633 816 t (70.9%)

4. PHYSICAL GEOGRAPHY

Bangladesh is a low-lying riverine country of South Asia on the northern edge of the Bay of Bengal. Most of the country is a flat deltaic plain formed by the Ganges and Brahmaputra rivers and their tributaries. There are low hills in the northeast and the Chittagong Hill Tracts in the southeast. The coastline is about 480 km long.

5. CLIMATE

Bangladesh has a sub-tropical monsoon climate. Winter is from November to February, and temperature ranges from a minimum 7.2-12.7°C to a maximum 23.8-31.1°C. Monsoon is from July to October. This period accounts for 80 percent of the total annual rainfall. The average annual rainfall varies from 1 193.8 to 1 454.4 mm. The maximum rainfall is recorded in coastal areas of Chittagong and northern part of Sylhet district, whereas the minimum is observed in the western and northern parts of the country.

6. HYDROLOGY

The country has very extensive inland water areas covering an aggregate of 4 199 694 ha.

6.1 Rivers

Bangladesh has a large delta of 144 000 km^2 that is formed by three main rivers: the Ganges (Padma), Meghna and Jamuna-Brahmaputra. The size of the riverine and other large inland perennial water bodies is estimated to be about 12 200 km^2, i.e., over 8 percent of the total area of the country. The lower reaches of the Ganges (Padma) and Brahmaputra (Jamuna) Rivers traverse the country from north to south, and have a length of more than 300 km each. The Meghna (128 km), Kalni (212 km) and the Karnafully (234 km) are the other major rivers in the country. Rivers, streams and canals have a total area of about 1 031 563 ha, and the floodplain area is about 2 832 792 ha.

6.2 Lakes

There are no large lakes, but a number of natural

depressions (beels) and ox-bows (baors) cover an area of about 119 649 ha.

6.3 Reservoirs

The Kaptai reservoir covers an area of about 68 800 ha.

7. LAND AND WATER USE

Bangladesh has fertile soil and ample water. Forests cover about 14 percent of the country's area. Ninety percent of the population earn their living directly or indirectly from agriculture. Sixty percent of the total land area is already cultivated, of which four-fifths is devoted to foodgrains and contributes nearly two-thirds of the agricultural output. Rice is the major food crop, accounting for over 90 percent of the total foodgrain output, but is still insufficient. The country produces more than 1.1 million tons of jute annually, and tea is the third most important crop.

8. FISHERY YIELD/PRODUCTION

Nominal yield from inland waters of Bangladesh (1982-91)*
(in tons)

1982	1983	1984	1985	1986
559 498	585 587	588 620	586 416	586 522
1987	**1988**	**1989**	**1990**	**1991**
597 106	599 523	607 645	610 624	633 816

* Includes aquaculture production.

9. STATE OF THE FISHERY

9.1 Yield

Bangladesh is rich in inland water resources, and the most significant aspect of its inland fisheries is therefore open water capture fisheries in the rivers, estuaries and floodplains, which are closely associated with the pattern of flooding that take place during the monsoon season. Seventy-two (72) percent of the country's total fish production is from inland waters. This amounted to 610 624 tons in 1990. The traditional small-scale year-round inland capture fisheries in open waters contributed about 69.4 percent of the total inland fisheries production and 191 924 t was derived from aquaculture (ponds, beels, baors and brackishwater aquaculture). Clearly inland water capture fisheries are the most important part of the fisheries sector in Bangladesh.

The dominant species of fish that is harvested from the rivers of Bangladesh is the hilsa (Hilsa ilisha), which accounts

for about 44 percent of the average riverine fish production. Of the three countries (Bangladesh, India and Myanmar) in the upper region of the Bay of Bengal, Bangladesh secures the largest share (more than 80 percent) of the landings from its inland river systems and inshore waters.

The giant freshwater prawn (Macrobrachium spp.) constitutes the second largest fishery (10.8 percent) after hilsa in the rivers in terms of total landings. The Ganges and Meghna River are the major sources of these species.

The majority of miscellaneous fish harvested from the floodplains are species dependent on floodplains for their spawning and early life. The floodplain fishery is mainly carried out for subsistance purposes throughout the monsoon season. It has been estimated that over 180 000 t of fish are annual harvested from floodplains annually, and about 10.8 million households involved.

Pond fish culture (mainly carps) is also an important component of the Bangladesh fisheries, and is a very old practice. Fish culture in ponds and tanks account for about 25 percent of the total inland production. There are about 1.3 million ponds in the country covering an area of 147 000 ha. Compared to potential, the present production is low because of high risk associated with flooding, drought and the lack of inputs and technical know-how. Generally, production from unfertilized ponds does not exceed 740 kg/ha/year.

9.2 Factors influencing yield

Although fish provides 80 percent of the total animal protein intake of the population, the per capita consumption of fish has declined from 11.7 kg per annum in 1972 to an estimated 7.5 kg per annum in 1990 due to high population growth.

Despite the importance of fisheries in terms of nutrition and employment, the inland fisheries in Bangladesh is faced with problems of overfishing and have been displaced and disrupted by flood control, drainage, irrigation, road embankments and other land uses. The erection of flood control dams has adversely affected the production from natural water bodies, resulting in declining annual yields in inland capture fisheries. The hilsa and major carp stocks in rivers and floodplains have declined because of embankments, sedimentation and overfishing. To enhance the fish stocks in these open water bodies and floodplains, the Department of Fisheries of Bangladesh has been carrying out an "open water stocking programme" in rivers and floodplains since 1988. A great attempt has also been made to develop fish culture in village ponds by providing technical know-how to farmers through extention. To meet the demand of fish seed in the rural areas, over 100 fish seed multiplication farms have been established and are in operation.

9.3 Forecast

As a deltaic country, Bangladesh has great potential for inland fisheries development. Most of the country's inland fisheries exploitation activities is small-scale and traditional, where it has retained an open access approach. However, the negative impacts of flood control, drainage and irrigation projects, and excessive fishing effort, have resulted in the decline of inland water catches. To overcome these constraints, apart from the "open water stocking programme" presently being carried out by the Government, new inland fisheries management policies are also needed for the conservation and development of resources. Fisheries development with emphasis on aquaculture on the other hand, has been given adequate priority in the national development plan. There are about 260 658 ha of impounded inland waters readily available for fish culture. Moreover, some 2.8 million ha of paddy fields are flooded 4-6 months each year, and an area of 182 900 ha of estuaries and other brackishwaters could be brought under aquaculture.

CAMBODIA

1. AREA: 181 035 km^2

2. POPULATION: 9 000 000 (est.) Density: 50 persons/km^2

3. TOTAL CATCH: 111 100 t Inland fish: 74 700 t (67.2%)

4. PHYSICAL GEOGRAPHY

The country is surrounded by low mountains and lowlands. A gently sloping plateau lies in the east, the Dangrek range runs from the east to west along the northern border for almost 300 km and the Cardamon mountains are in the southwest, extending further to the southeast as the Elephant range. A central plain, drained by the Great Lake and the Mekong and Bassac River system, contrasts with the Cardamon Mountains in the southwest of the country and the Dangrek Mountains in the north along the Thai border. The country has a coastline of 435 km and extensive mangrove stands.

5. CLIMATE

The country has a tropical monsoon climate. The rainy season is from May to the end of October. The dry season is often divided into the cool season from November to February and the hot season from March to the end of April. The annual rainfall for Phnom Penh is about 1 406 mm, with the highest average monthly rainfall occuring in October at the end of the monsoon season. January has the lowest average monthly rainfall level. Temperatures in Phnom Penh fluctuate from a low of 21°C in January to a high of 34°C in April.

6. HYDROGRAPHY

6.1 Rivers

The Mekong and its tributaries form the main river system and therefore dominates the hydrology of the country. The section of Mekong River that passes through Cambodia lies within the tropical wet and dry zone. The Mekong River's average annual flow at Kratie of 441 km^3 is estimated as 93 percent of the total Mekong run-off discharged into the sea. The Tonle Sap River and the great lake (also called Tonle Sap Lake) drain the western half of Cambodia.

6.2 Lakes

The Great Lake lies in the centre of the country. During monsoon season, the floodwaters of the Mekong River reverse the flow of the Tonle Sap River (about 120 km in length) and enter the lake, thus forming the largest natural lake in Southeast Asia. Under the impact of the inflowing Mekong River, water in the lake rises by an average 7 m, and its surface increases to 10 000 km^2, and exceptionaly to 13 000 km^2. The lake then acts as a natural flood retention basin. When the floods subside, water starts flowing out of the lake; this reduces the lake area to about 3 000 km^2 and a depth of about 1-4 m.

7. LAND AND WATER USE

Cambodia is an agriculture country. The main crops are rice and maize that are grown on 20 percent of the land. Forests cover 74 percent of the total land area, and timber produced in large quantities, provides the major export revenue of the country.

8. FISHERY YIELD/PRODUCTION

Nominal yield from inland waters of Cambodia (1982-91)*
(in tons)

1982	1983	1984	1985	1986
65 700	58 717	55 093	56 400	64 181
1987	**1988**	**1989**	**1990**	**1991**
62 154	61 200	50 500	65 100	74 700

* Includes aquaculture production.

9. STATE OF THE FISHERY

9.1 Yield

Freshwater fisheries continue to be the major part of fishery production in the country. The inland capture fisheries in Cambodia are governed completely by the annual cycle of hydrological events, the filling and the draining of the Great Lake by the Tonle Sap River, and the annual flooding of the plains around and downstream of Phnom Penh, where it determines the longitudinal and lateral migrations and reproduction of most of the fish species. The Great Lake accounts for about 60 percent of the total country inland fisheries production.

Over 200 fish species inhabit the inland waters of Cambodia, most of which are captured and used as food, as freshwater capture fisheries contributes 75-90 percent of the animal protein supply to the Cambodian population. The dominant fish species of the Great Lake are carp (cyprinids) (54 percent), catfish (19 percent), murrel (9 percent) and other miscellaneous fish

species.

9.2 Factors influencing yield

Inland capture fisheries is mainly dependent on flood plain fisheries, which is completely governed by the annual cycle of hydrological events, and can be subdivided into two main components on basis of their location: the Great Lake (Tonle Sap) fishery, and the Mekong Bassac inundation zone fishery (comprised of the area between Kratie and Phnom Penh and the Mekong/Bassac Delta to the Vietnamese border). The three highest inland fish producing provinces are Siem Reap, Kampong Chhnang and Kandal, situated on the Great Lake and the Mekong River down to the Vietnamese border, contributing 50 percent of the total production from inland fisheries in 1992.

The inundated forest of the Great Lake, and to a lesser extent the inundated forests of the Tonle Sap and Mekong rivers, are considered to be essential for maintaining the current level of inland fishery production, as 90 percent of the total freshwater fish stocks follow the inundation spawning pattern and many of the fish species breed in the inundated forests. However, fish stocks and fisheries are adversely affected by gradual environment degradation. Apart from overfishing, increase pressure on land, deforestation of catchments and the conversion of such lands to agriculture, and mining in catchment of some rivers entering the Great Lake, have increased soil erosion and siltation of the lake.

9.3 Forecast

A series of measures have been introduced in the past to protect fish stocks, i.e., a closed season from June to September for industrial and artisanal fishing, the establishment of fish reserves, fishing for certain rare species (*Pangasionodon gigas* and *Catlocarpio siamensis*) and prevention of illegal fishing. These measures have had, to some extent, contributed to the stabilization of catches. The rehabilitation of the freshwater fisheries has yet a long way to go, and a multisectorial development plan to enhance floodplain fisheries is required in order to maintain production and ensure sustainability.

Although cultured fish in the past have not played an important role in the volume of fish supply due to the abundance of wild fish in Cambodia, aquaculture (pen and cage culture) holds considerable potential. Improvements in pen and cage culture are possible, priority however, should be assigned to the development of small-scale methods as a means of enhancing food security.

CHINA

1. AREA: 9 600 000 km^2

2. POPULATION: 1 133 682 501 Density: 118 persons/km^2

3. TOTAL CATCH: 13 134 967 t Inland fish: 5 528 126 t (42%)

4. PHYSICAL GEOGRAPHY

China is situated west of the Pacific Ocean and east of the Asian continent. The country extends 5 000 km from east to west, and more that 5 500 km from north to south.The topographic feature of China is that it is high in the west and low in the east. The Qinghai-Xizang Plateau is the highest in the west, with an average altitude between 4 500-5 000 m above sea level. Next is the Yunnan-Guizhou, Huangtu and Mengxin Plateau that are at 1 000-2 000 m altitude. The third plateau includes plains of the Northeast, North and East China, the intermediate and lower reaches of the Yangtze River plain and the Southeast China hilly areas. The first and second plateaux account for 52.2% of the total area, whereas plains in the third area account for 47.8%. China's topography is classified into five major categories: mountainous regions (33 percent), plateau (26 percent), basins (19 percent), plains (12 percent) and hilly areas (10 percent).

5. CLIMATE

China is situated in a tropical, sub-tropical and temperate zones. The dry season is from October to March, the wet season from April to September. Annual rainfall gradually decreases from the southeast to the northwest. Rainfall in the intermediate and lower reaches of the Yangtze River and in the majority areas of southern China may attain 1 000-2 000 mm, rainfalls in Taiwan and east of Hainan Island may be in excess of 2 000 mm. The Huang and Huai plains and the eastern part of northeastern areas of China have 500-1 000 mm, the western part of the northeast areas and the Loess plains 200-500 mm. The western part of Inner Mongolia, the northern part of the Qinghai-Xizang Plateau and most parts of the Autonomous Region of Xinjiang have annual rainfalls below 200 mm. The average temperature for January varies from -20°C in the north, to 16°C in the south. July is usually the hottest month in most parts of China, with average temperatures varying between 16°C to 29°C.

6. HYDROLOGY

China has a network of rivers, lakes, streams, reservoirs and ponds, with a total water area of 17 471 300 ha, of which 9 043 430 ha is suitable for inland fisheries and aquaculture. There is also 27 million ha of paddy fields and 20 million ha of saline/alkaline and low-lying waste land.

6.1 Rivers

There are about 50 000 rivers that have a drainage area exceeding 100 km^2 each. 104 rivers are longer than 300 km; of these 22 exceed 1 000 km. 56.7% of the rivers flow into the Pacific, with 6.5% and 0.5% flowing into the Indian and Arctic Ocean respectively. The rest has an endorheic drainage.

The major rivers in China from north to south are the Heilongjiang (3 101 km in length with drainage area of 887 000 km^2), Huanghe (Yellow) River (5 464 km with drainage area of 750 000 km^2), Huaihe River (1 000 km and drainage area of 269 000 km^2), Changjiang (Yangtze) River (6 300 km and drainage area of 1 800 000 km^2) and Zhujiang (Pearl) River (2 210 km and drainage area of 443 000 km^2); these rivers flow from west to east and discharge into the Pacific. The two rivers that flow into the Indian Ocean are the Nujiang and the Yaluzanbojiang in the southwest part of China.

The Yangtze River has more than 1 700 floodplain lakes with a total water area of 2.33 million hectares (31% of the total lake area in China). The Pearl River and the Yangtze River Delta have the most important freshwater fisheries in China.

6.2 Lakes

The total surface area of lakes in China is 7.52 million ha. Lakes in China are concentrated in five areas: (i) lakes in the eastern plains cover 2.33 million ha or 31% of the total lake area; (ii) lakes in the northeastern plains have a water area of 434 000 ha (5.7%); (iii) the Yunnan-Guizhou area has 110 000 ha (1.4%) of lakes; (iv) the Mongolian-Xinjiang area has 867 000 ha (11.5%) of lakes and, (v) Qinghai and Xizang area has 3 656 000 ha (48.4%) of lakes.

Although lakes in the Qinghai and Xizang area represent 48.4% of the total lake area in China, most of them are inland and seasonal lakes with high evaporation, resulting in salt-water character of many of them. The five major freshwater lakes (Poyang, Dongting, Hongze, Cao and Tai) are located in the eastern plains, and rank first in lake fisheries of the country.

6.3 Reservoirs

There are a total of 82 870 reservoirs in China, of which 353 are large reservoirs, 2 428 medium size and 80 089 small reservoirs (1991). The total water area of these reservoirs is 2.3 million ha. The number of reservoirs for the northeastern,

northwestern and north China, the intermediate and lower reaches of the Yangtze River basin, southern and southwestern China is 20, 7.6, 16, 33, 16.4 and 7 percent respectively. The major functions of reservoirs in China are flood control, irrigation and hydropower.

7. LAND AND WATER USE

In 1990, 95 673 866 ha of land was cultivated. Of which 25 512 266 ha or 26.6 percent were paddy fields. Rice, wheat, maize, sorghum, millet, soybean, sweet-potatoes, cotton, groundnuts, rape-seed, sesame, sunflower, cane and beet sugar, jute and tobacco, etc., are the main agriculture and industrial crops. Total grain production for 1990 was 451.84 million tons. The total irrigated area in 1990 was 47.67 million ha. There were 115.25 million ha of forests, which is 12 percent of the total land area.

8. FISHERY YIELD/PRODUCTION

Nominal yield from inland waters of China (1982-91)*
(in tons)

1982	1983	1984	1985	1986
1 562 000	1 840 775	2 249 707	2 854 315	3 481 743

1987	1988	1989	1990	1991
4 071 506	4 551 914	4 857 173	5 237 621	5 528 126

* Includes aquaculture production.

9. STATE OF THE FISHERY

9.1 Yield

In the total inland yield of 5 237 621 tons for 1990, aquaculture accounted for 4 459 114 tons (85.1%). The total freshwater area in China is 17 471 300 ha, of which 9 043 430 ha is suitable for aquaclture. At present, 6 439 080 ha is being utilized. In recent years, cage and pen fish culture has gained momentum, reaching in 1990, 500 ha and 70 000 ha respectively. Raceway culture has also been introduced and practiced on a limited scale in China. The dominant groups of fish presently under culture are eel, rainbow trout, tilapia and common carp. The area under culture, production and yield of different inland culture practices are as follows:

	Area (ha)	Total production (tons)	Yield (kg/ha)
Pond culture	1 415 430	3 370 527	2 385
Lakes	615 770	267 340	435
Reservoirs	1 421 590	359 835	255
Rivers	331 980	263 749	795
Others	49 950	66 826	1 335
Rice fish culture	740 830	130 837	180

9.2 Factors influencing yield

In 1990, China became the largest fish producer in the world in terms of the total production. In inland fisheries and aquaculture production, it has been in a leading position for more than a decade, with the total freshwater aquaculture area and production in 1990 of 3.83 million ha and 4.46 million tons respectively. Major policy reforms that have been implemented in the country for the past decade, have provided fisheries development with unified responsibilities, rights and benefits that include multiple systems of ownership and diversified operational methods. Such flexibility in policy has resulted in a better utilization of the existing resources and in a substantial increase in yield. However, such growth still does not meet the demand of a large population with a rapidly improving living standard, where the present per capita consumption of aquatic products is still only 10.66 kg.

9.3 Forecast

Apart from increasing the yield of semi-intensive and intensive culture in the existing water bodies, there is considerable potential for the further development of China's freshwater inland fisheries, where 2 604 350 ha of cultivable water area is still without fisheries. This includes 195 950 ha of ponds, 1 534 770 ha of lakes, 462 240 ha of reservoirs and 434 150 ha of rivers. The major constraints that at present hamper the development of China's fisheries are: obsolete production facilities, production cost, lack of funds and inadequate distribution, storage and processing systems for aquatic products. To overcome such drawbacks will require more funds, renovation or reconstruction of existing fish ponds to make possible the implementation of semi-intensive or intensive fish culture with a more integrated approach, expansion of cage and pen culture for the better utilization of open water bodies, development of rural and urban markets and updating of the existing transportation, storage and processing facilities, and further strengthening of fisheries infrastructure and social services.

MALAYSIA

1. AREA: 331 800 km^2

2. POPULATION: 18 600 000 Density: 56.1 persons/km^2

3. TOTAL CATCH: 620 000 t* Inland fish: 14 477 t* (2.3%)

* FAO Fishery Statistics, 1991

4. PHYSICAL GEOGRAPHY

Malasia occupies the Malay Peninsula now known as Peninsular Malaysia, and the northwestern quarter of the neighbouring inland of Borneo known as Sabah and Sarawak, called East Malaysia. The two parts are separated by 643 km of the South China Sea.

Peninsular Malaysia has an area of 131 235 km^2. A range of steep, forest-covered mountains runs north and south along the centre of the peninsula, flanked on the east and west by coastal plains. In East Malaysia which has an area of about 200 565 km^2, Sarawak has a broad, frequently swampy, coastal plain, crossed by a number of rivers. The plain merges into the jungle-covered hills and mountains of the interior. Sabah has a narrow coastal plain, and gives away to a mountainous, jungle-covered interior culminating in Mount Kinabalu, which is the highest peak in Malaysia (4 100 m).

5. CLIMATE

The tropical rain forest climate is characterized by uniformly high temperatures with copious rainfall and high humidity, and southwest and a northeast monsoons. Monthly temperatures are fairly constant throughout the year. The average daily temperature varies from about 21° to 32°C, although in the higher altitudes temperatures are lower and more variable. Annual rainfall averages 2 540 mm, but it varies considerably in different locations and from year to year.

6. HYDROLOGY

6.1 Rivers

The major rivers are: Pahang (459 km), Perak (406 km) in the Malay Peninsula; the Rajang (563 km), Batang Lupan (199 km), Baram (402 km), Limbang (196 km) in Sarawak, and the Kinabatangan (563 km) in Sabah.

6.2 Lakes

There are very few natural lakes in the country. The major lakes are: Tasik Cini (902 ha), Tasik Bera (6 150 ha) both in Pahang state and Loagan Bunut (800 ha) in Sarawak.

6.3 Reservoirs

The total surface area of reservoirs is over 80 000. A major proportion of this represent large reservoirs for hydroelectric power generation. The Kenyir reservoir in Terengganu is the largest, with an area of 39 600 ha and a maximum depth of 130 m. The Temenggor reservoir which is the second largest (15 000 ha) is part of the chain of reservoirs for the Hydroelectric scheme in Perak River Valley which also includes Bersia (570 ha), Kenering (4 050 ha) and Chendero (2 200 ha) reservoirs. The maximum depth of Temenggor is 46 m. The largest reservoirs for irrigation purposes are the Pedu in Kedah state (6 400 ha), and Bukit Merah reservoir (3 500 ha, an average depth of 3.5 m).

7. LAND AND WATER USE

Malaysian economy is dominated by agriculture. There are 5.0 million ha of cultivated lands in the country, of which almost sixty percent are covered in rubber trees, mostly along the western coast of Malacca, Sarawak and Sabah. Malaysia is the largest natural rubber producer in the world. Cocoa and palm oil are the other major industrial crops of the country. Only about nineteen percent of the cultivated land is used for growing rice. The country is not self-sufficient in food and so relies on imports to complement its requirements. About eight percent of the country is covered by tropical jungle.

8. FISH YIELD AND PRODUCTION

Nominal yield from inland waters of Malaysia (1982-91)*
(in tons)

1982	1983	1984	1985	1986
16 332	15 141	3 081	6 368	4 722
1987	**1988**	**1989**	**1990**	**1991**
12 743	7 830	8 193	10 965	14 477

* Includes aquaculture production.

9. STATE OF THE FISHERY

9.1 Yield

The major activity in inland fisheries is pond fish culture. In 1990 (Malaysia), a total area of 4 890 ha of fishponds and disused mining pools produced 9 173 t of fish, mainly practiced at a subsistance or artisanal level by the part-time fish farmers. The average yield was around 1 875 kg/ha, consisting mainly of carps. Apart from fish ponds, 516 t were produced from freshwater cage culture, 1 276 t from rivers, lakes and impoundments, and 5 099 t from brackishwater, making up a total of 16 064 t, a figure considerably in excess of that indicated by the nominal catch statistics.

In 1990, inland and brackishwater aquaculture produced 52 303 t from 12 302 ha. Approximately more than 69 percent of this production were cockles, marine finfish, shrimps, crabs and oysters.

9.2 Factors influencing yield

By Asian standards, Malaysia has only very few large rivers and lakes, and there is little management or monitoring of riverine and lake fisheries. A number of sizeable reservoirs are available but are not yet fully utilized. Fish ponds now cover 7 000 ha. Brackishwater pond development has been slow mainly due to the high cost of pond construction and the shortage of fry and management skills.

9.3 Forecast

Freshwater fisheries play a significant role in providing animal protein for people especially in the remote rural and depressed areas of the country. The potential for development is large. There are at present 307 469 ha of freshwaters and 499 764 ha of brackishwaters which could be utilized. The development of aquaculture has been accorded a priority under the National Agriculture Policy. The number and area of reservoirs is rapidly increasing and provides a good opportunity for fisheries development including commercial and recreational fisheries and fish pen/cage culture. It is envisaged that the total surface area of reservoirs in Malaysia will reach about 200 000 ha by the turn of the century.

MYANMAR[1]

1. AREA: 676 577.5 km^2

2. POPULATION: 38 541 119 Density: 56.9 persons/km^2

3. TOTAL CATCH: 769 236 t* Inland fish: 175 149 t* (22.7%)

* FAO Fishery Statistics, 1991

4. PHYSICAL GEOGRAPHY

Myanmar in Southeast Asia is situated within the tropics, facing the Bay of Bengal and the Andaman Sea. The country is rimmed in the north, east and west by mountain ranges with elevations of up to 4 075 m above sea level along the border with China, and 2 999 m along the Indian border. The gently sloping valley of the Irrawaddy River extends from north to south in the central area and the mountainous Shen Plateau with its turbulent Salween River lies in the east.

5. CLIMATE

The country has a tropical monsoon climate. Three seasons are distinctive: hot season (March-May); rainy season (June-October) and cool season (November-February). Mean annual temperature ranges from about 27°C in soutnern Myanmar to about 24°C in the northern lowlands. During the hot season, temperatures often exceed 40°C in central Myanmar. Annual rainfall varies from 5 000 mm in coastal areas to only 770 mm in the central dry zone.

6. HYDROLOGY

6.1 Rivers

There are three main river systems: Irrawaddy-Chindwin, Sittang and Salween. The tributaries of these rivers form the major freshwater fishing area in the country. The Irrawaddy (Ayeyarwady) River is the country's economic lifeline and major transportation system, connecting Yangon with Mandalay in the central area. It originates from the province of Yunnan in southwest China, flows about 2 150 km from north to south in

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[1]This information has been compiled in FAO Headquarters, Rome. It is based largely on the following source: Proceedings of the Workshop on Fishery Industries Development, Myanmar, September 1992.

Myanmar and empties into the Andaman Sea through a 31 000 km^2 deltaic alluvial plain much of which is flodded seasonally. The Chindwin River flows 844 km from the northwest region of Myanmar, and joins the Irrawaddy at its centre. The Sittang (Sittaurg) River, 563 km long, and the Salween (Thanlwin) River, 2 900 km long, flows in a direction parallel to the Irrawaddy.

6.2 Lakes

The two main lakes are Inle and Indawgyi. The Inle lake on the Shan Plateau is situated at an elevation of 3 000 metres above sea level, and has an area of 12 430 ha. This lake and its basin form a closed system, without connection with any of the important rivers. The Indawgyi lake, located in Kachin State, has an area of 20 700 ha.

6.3 Reservoirs

There are 41 major reservoirs with a total water surface area of about 80 000 ha. Almost all of these reservoirs have been declared as a fishery water area, and fishing rights are granted either by lease or through fishing licences.

7. LAND AND WATER USE

Myanmar is one of the least densely populated countries of southeast Asia. Land equal in area to that under cultivation is available for development. At present the cultivated area is about 8.28 million ha and agriculture supports two-thirds of its population. Rice is the main crop, which is grown on 60 percent of the cultivated area. Other crops are groundnuts, sesame seeds jute, pulses and sugar cane. The total irrigated area is about 12 percent. Myanmar possesses about 75-85 percent of the world's teak reserves. Forests, mainly teak, cover about 57 percent of the country.

8. FISHERY YIELD/PRODUCTION

Nominal yield from inland waters of Myanmar (1982-91)*
(in tons)

1982	1983	1984	1985	1986
133 840	142 870	147 954	151 844	151 357

1987	1988	1989	1990	1991
144 985	144 818	143 231	144 586	175 149

* Includes aquaculture production.

9. STATE OF THE FISHERY

9.1 Yield

Inland fisheries are based mainly on extended seasonally inundated floodplains. Such floodplains are estimated to form a water surface of about 6 million ha for a period of 4-5 months a year, and produced about 103 180 t fish per annum, which is about 17 kg/ha. Rivers and lakes produce about 38 578 t, and freshwater aquaculture 5 044 t.

9.2 Factors influencing yield

Inland fisheries production continues to come largely from the river systems of the country. To enhance the natural productivity of the freshwater fisheries, the Government has conducted a programme of annual stocking of natural water bodies and reservoirs. A total of 38 377 million fish seed have been stocked in these waters in the past. Carp culture is well established in the country, and the extensive pond fish culture dominates.

9.3 Forecast

The fisheries sector is of a considerable importance for Myanmar's economy, as fish constitutes a major source of animal protein in the diet of the people, and also represent the fourth largest source of foreign exchange earnings after timber, minerals and rice. With the changing to a more market oriented economy system, fisheries development plans are now produced on an annual basis. They have targeted an annual increase of fish production of at least 5%. Most of the existing grow-out fish culture systems are extensive. Further development of inland fisheries may have to be based on intensification of aquaculture.

NEPAL

1. AREA: 147 181 km^2

2. POPULATION: 18 500 000 (1991) Density: 146 persons/km^2

3. TOTAL CATCH: 15 595 t Inland fishery: 15 595 t (100 %)

4. PHYSICAL GEOGRAPHY

The Kingdom of Nepal is a landlocked country which lies on the southern slopes of the Himalayas, between India and the Tibetan region of China. It measures about 880 km from east to west and between 130-240 km from north to south. The country, geographically, may be regarded as a series of steps, of which the Southern Terai plain is the lowest at an average altitude of about 150 m above sea level. The Siwalik hills rise from the Terai to a height of 1 600 m then, continuous with the Mahabharat range, attains altitudes of 3 000 m, and finally the Himalayan ranges rise over 8 000 m.

5. CLIMATE

In general Nepal is mountainous, subtropical monsoon in climate, but varies from the summer tropical heat and humidity of the Terai to the colder, dry, continental and alpine winter climate of the middle and northern mountainous sections. At Kathmandu, the average high temperature is 30°C in May and average low is 1.6°C in December. The monsoon season is from June to September and about 80 percent of the precipitation is confined to this period, ranging in amounts of more than 4 000 mm in portions of the eastern half of the country to less than 1 000 mm in the extreme northern and western areas. From October to March, sunny days and cool nights prevail.

6. HYDROGRAPHY

6.1 Rivers

There are three major river systems, the Koshi to the east, the Gandaki in the middle and the Karnali to the west. All the major rivers are originally snow-fed from the Himalayas, but are joined by tributaries arising in the Mahabharat and Siwalik ranges, flowing south to the plains. All systems are strongly influenced by the annual monsoon, and during that period flow rates may increase by a factor of 10 to 20 times. The total length of all rivers in the country is about 11 800 km.

6.2 Lakes and reservoirs

There are many lakes, reservoirs and smaller water bodies that are associated with the river system in the country. The lakes and reservoirs are estimated to cover 5 000 ha and 1 380 ha respectively. Hardly any work has been done on the fisheries aspects of the lakes and reservoirs except the Pokhara valley lakes (745 ha) and the Kulekhani reservoir (220 ha). About 5 000 ha of village ponds mostly located in the Terai area are being utilized for fish culture.

7. LAND AND WATER USE

Nepal is mountainous with only about 30 percent of the total area being cultivable. Another 33 percent is forested. Seventy percent of cultivated land is in the Terai, and only about 30 percent is found in the hilly areas. The principal crops are rice, maize, wheat, millet, barley and potatoes. Jute, oilseeds, tobacco and sugarcane are also grown in the Terai. An attempt has been made over recent years to control the water supply to avoid drought and floods. Many of the rivers are at least partially controlled with irrigation weirs or hydroelectric dams, and about 14 percent of arable land is irrigated at present. During the last decade about one quarter of the country's total forest cover has been destroyed, mostly for use as firewood and charcoal. The removed of tree cover has exposed some areas to soil erosion.

8. FISHERY YIELD/PRODUCTION

Nominal yields from inland waters of Nepal (1982-91)*
(in tons)

1982	1983	1984	1985	1986
4 400	4 700	7 941	9 079	9 443
1987	**1988**	**1989**	**1990**	**1991**
10 716	12 100	12 522	14 547	15 595

* Includes aquaculture production.

9. STATE OF THE FISHERY

9.1 Yield

All major rivers are fished. There are 1 500-2 000 professional fishermen along the potential reservoir reach of the Bagmati River along. The fishery concentrates on the migratory major cyprinids at the beginning and end of the monsoon. Some fishing continues throughout the dry season and in places is intensified at extremely low water. In 1991, 5 281 t of fish were produced through capture fisheries which include rivers, lakes, reservoirs and irrigated paddy fields, and 10 314 t of fish were produced through culture fisheries in village ponds and cage

culture. A breakdown of the fisheries production (in tons) from 1985 to 1991 is provided in the following Table:

Year	Total yield	Capture fisheries*	Culture fisheries	Pond fish culture
1985	9 079	5 281	3 798	3 232
1986	9 443	5 281	4 162	3 670
1987	10 716	5 281	5 435	4 947
1988	12 100	5 281	6 819	6 368
1989	12 522	5 281	7 241	6 837
1990	14 547	5 281	9 266	8 859
1991	15 595	5 281	10 314	9 899

* Estimates.

9.2 Factors influencing yield

The development of capture fisheries, cage culture in lakes and the expansion of aquaculture lead to a sustained increase in production. There are currently thirteen fish development centres operational, and about 41 million fry are produced and stocked into 5 235 ha of village lakes, private fish ponds and cages (13 364 m^3) in lakes of the Pokhara valley. The Kulekhani Inland Fisheries Project concentrates on increasing fish production in reservoirs. There are 11 private fish hatcheries producing about 27 million fry and fingerlings. The rivers in the hills of the country are mostly fast flowing torrents with rocky and stone beds. They hold a plentiful supply of fish food organisms which sustain a diversified fish fauna.

9.3 Forecast

Nepal has both riverine and lacustrine fishery resources as well as potential for further expansion of aquaculture. The first priority has hitherto been the development of aquaculture and fisheries in the lakes. The next priority is to begin development and management of the reservoirs and riverine fisheries resources. Many dams or weirs are being constructed in the rivers for both hydropower and irrigation and this means that migration of the larger species may be interrupted. The detrimental effects of dam construction may be offset by improved production from the upstream reservoirs, but this will require stocking.

Areas under fish culture are expanding and improvements in technology are currently being making it possible to intensify production and obtain higher yields. National and international agencies, such as UNDP/FAO, Asian Development Bank (Manila), International Development and Research Centre (Canada), Japan International Cooperation Agency etc., have been providing support to fisheries programmes in the country.

His Majesty's Government of Nepal has given due priority to aquaculture development, and it is expected that this programme will play a significant role in raising the nutritional standard

of the Nepalese people. An expanding fish culture also provide employment and raises the income of rural households. In 1991, the per capita fish consumption has been 819 grammes.

NEW ZEALAND

1. AREA: 269 792 km^2

2. POPULATION: 3 450 000 Density: 13 persons/km^2

3. TOTAL CATCH: 609 031* Inland fish: 1 347 t* (0.22%)

* FAO Fishery Statistics, 1991

4. PHYSICAL GEOGRAPHY

New Zealand comprises mainly two large islands, lying in a northeast/southwest arc in southern temperate latitudes (34°-48°S), with numerous small islands close offshore, and groups of more distant islands up to 800 km away. The two main islands are mountainous, those of the South Island reaching an altitude of 3 764 m, with extensive mountainous areas over 2 000 m. Lower lands are extensively developed for pastoral agriculture, cropping, horticulture and forestry, especially in the lowlands, though pastoral farming and forestry extend into the lower elevation mountains.

5. CLIMATE

The climate varies from warm temperatures in the north to cool temperates in the south. Rainfall may reach 10 m or more in the high mountains close to the South Island's west coast, and falls over 2 500 mm occur widely; most of New Zealand has rainfall over 800 mm per annum. Rainfall in areas east of the main mountain ranges may be less than 800 mm. Winds from the westerly quarter are most common at all seasons of the year. Mean temperatures vary from about 15° and 5°C from north to south, with summers generally warm (to about 25°C) and winters cool (to about 5°C); frosts are prevalent in winter in inland and southern locations; snow occurs but usually persists only briefly at lower elevations in winter, but there are extensive permanent ice and snow fields at high elevations.

6. HYDROGRAPHY

6.1 Rivers

Rivers are numerous, with about 300 estuaries around the coastline. The longest river is the Waikato (425 km), others being the Clutha (322 km) and Wanganui (290 km); the highest mean annual discharges are from the Clutha (557 m^3/s) and Waikato (402m^3/s). Many rivers are short and swift-flowing, owning to the steep topography, and the elongate, narrow shape of New Zealand's main island.

6.2 Lakes

Lakes are also numerous, many of them being subalpine to upland. Most are small, with most (93%) being less than 5 km^2 in area and only 14 (2%) with area greater than 50km^2. The largest are Taupo (600km^2), Te Anau (344 km^2), Wakatipu (239 km^2); the deepest lakes are Hauroko (462 m), Manapouri (444 m), Te Anau (417 m), Hawea (384 m) and Wakatipu (380 m). Lake Ellesmere (182 km^2) is a large shallow (about 2 m) coastal brackish lake separated from the sea by a narrow shingle bar, the largest of several lakes of this type.

6.3 Reservoirs

Many rivers have been impounded to control flows, mostly for hydroelectricity generation, but some for water supply for farming uses or human water supply; the Waikato, Waitaki and Clutha are the most intensively developed in this way.

Most of the reservoirs formed are small, the largest being lake Benmore (75 km^2) and Aviemore (29 km^2) on the Waitaki, and Mahinerangi (21 km^2) on the Taieri River.

7. LAND AND WATER USE

The population is widely spread, though about one half lives in the northern part of the North Island. Although New Zealand is mountainous, there are extensive areas now intensively used for pastoral/arable land, with more than 50 million sheep for both meat and wool production, extensive beef and dairy cattle herds(> 8 million), nearly 1 million deer, as well as pig and goat farming and poultry production. There is extensive cropping of cereals (wheat, barley, oats, maize and peas), as well as horticulture for pip and stone fruits and berries.

Forestry is extensive, with about 7.4 million ha of New Zealand still forested. Indigenous forestry production is declining rapidly as available resources are exploited, and accessible unmilled forests is now either scarce or protected by reservations. Exotic coniferous forest is extensive, covering more than 1.2 million ha. Exotic forestry production is used for saw logs, timber, and pulp, paper and particle board production.

8. FISHERY YIELD/PRODUCTION

Nominal yield from inland waters of New Zealand (1982-91)
(tons exported)

1982	1983	1984	1985	1986
873	1 123	885	917	1 044
1987	**1988**	**1989**	**1990**	**1991**
883	1 025	1 150	1 255	1 347

9. STATE OF THE FISHERY

9.1 Yield

Fishery production from fresh waters is based almost exclusively on wild-caught freshwater eels (*Anguilla* spp.), with undetermined but small quantities of other , small indigenous fishes.

The most important freshwater fisheries are recreational fisheries for introduced salmonid species, primarily brown and rainbow trout and chinook salmon, the latter with anadromous runs in the eastern central South Island. These fisheries have considerable economic benefit from tourism activities generated.

Aquaculture production is modest, based on freshwater pond rearing production of chinook and sockeye salmon; attempts to develop commercial ocean ranching of chinook salmon have proved uneconomic. Farming of trout species, as well as commercial exploitation and sale of wild-caught trout or salmon is prohibited by law.

Crustacean aquaculture is very small, with pilot operations of *Macrobrachium* using waste geothermal waters, and unsuccessful attempts to farm indigenous parastacid crayfishes.

9.2 Factors influencing yield

Existing wild eel fisheries are under severe pressure from exploitation, with production sustained only by shifting effort to unexploited stocks, of which few remain. Average size of eels caught and production of the larger fisheries (lower Waikato River, Lake Ellesmere) are declining owing to fishing pressure.

9.3 Forecast

There is scope to increase production from freshwater pond reared salmon, the limiting factors being availability of markets, and economics of production; availability of suitable fish meals for rearing salmonids could also be a constraint. Eel culture has been attempted in the past and has proved uneconomic; there is periodic resurgence of interest but no obvious prospect of a viable industry. Production from recreational salmonid fisheries is likely to be limited by consumptive water management practices, impoundment of wild rivers and other changes to rivers.

PAPUA NEW GUINEA

1. AREA: 464 240 km^2

2. POPULATION: 4 000 000* Density: 8.61 persons/km^2*

3. TOTAL CATCH: 25 330 t** Inland fish: 13 300 t** (52.5%)

* Estimates.
** FAO Fishery Statistics, 1991

4. PHYSICAL GEOGRAPHY

Papua New Guinea (PNG) comprises many islands, including the eastern half of New Guinea. The western half of this island is Irian Jaya, a province of Indonesia. The New Guinea island is geologically divided longitudinally into northern and southern sections by the central range of mountains, the central cordillera. The island is largely covered by tropical rainforest which reflects its tropical location, benign climate and ample rainfall.

5. CLIMATE

PNG's climate is monsoonal.The northwest monsoon season extends from December to March and the southwest monsoon from May to October. Average annual rainfall is high, ranging from 2 000 to 2 500 mm for most districts. Many areas receive more than 5 000 mm with recorded maxima of 10 000 mm. Most lowland areas have a daily average temperature of about 27°C, with slight seasonal variations.

6. HYDROLOGY

The country has extensive inland water areas which mainly comprise large river systems, with associated floodplains, floodplain lakes and deltas.

6.1 Rivers

The three largest rivers in PNG are the Fly, Sepik and Purari, all located on the island of New Guinea. The Fly River has a length of 1 100 km, a catchment area of 79 000 km^2 and a floodplain area of 28 000 km^2; the Sepik River has a length of 1 200 km with a catchment area of 83 000 km^2 and floodplain area of 6 900 km^2; the Purari River has a length of 700 km, a catchment and floodplain areas of 33 000 and 1 500 km^2 respectively.

6.2 Lakes

The two important lakes associated with river floodplains are Lake Murray that covers 647 km^2 during the high water level, has a mean water depth of 4-6 m and discharges into the Strickland/Fly river systems; the other is the Chambri Lake, which is also a shallow lake situated on the Sepik River floodplain. It can cover 250 km^2 in the flood season and less than 50 km^2 during the dry season.

6.3 Reservoirs

There are very few and small reservoirs in PNG. Of these, two (both for hydroelectric power production) are worth mentioning: the Sirinuma on the Laloki River near Port Moresby, and the Yonki on the Ramu River.

7. LAND AND WATER USE

PNG is mostly covered by dense tropical rain forest, yet many of the inland soils are shallow, heavily leached and relatively infertile, resulting from heavy rainfall which has degraded the soils. Exceptions are several broad lowland valleys of a few rivers, such as the Markham and Ramu, where alluvial loams or soils of volcanic origin are very productive. About 84 percent of the total PNG population live in inland areas and most at subsistence level.

8. FISHERY YIELD/PRODUCTION

Nominal yield from inland waters of Papua New Guinea (1982-91) (in tons)

1982	1983	1984	1985	1986
13 500	13 500	13 500	14 500	14 500
1987	**1988**	**1989**	**1990**	**1991**
14 500	14 500	14 700	14 570	13 300

All estimates from FAO Fishery Statistics.

A rough estimate of inland fishery production is about 9 000 to 14 000 t annually, this is practically all subsistance catch. Despite the relatively low yield of inland fisheries as compared to the tuna fishery (100 000 t, with more than 90% taken by foreign based vessels), the floodplain subsistance fishery represents one of the country's most important fisheries in terms of direct benefits to the population. Few inland fishermen fish "commercially" but their catch is an important benefit to them both nutritionally and by means of barter and trading for other products. Fish obtained from fresh waters are therefore the major potential source of animal protein. It is estimated that about 11 500 people fish the Sepik floodplain.

9. STATE OF THE FISHERY

Native PNG freshwater fishes with one exception--*Scleropages* spp. are all derived from what are still essentially marine families. The main native families that occur in the Fly River system are Megalopidae, Clupeidae, Engraulidae, Ariidae, Plotosidae, Anguillidae, Centropomidae, Theraponidae, Lutjanidae, Sciaenidae, Toxotidae and Eleotridae.

The introduced tilapia (*Oreochromis mossambicus*) account for half of the present catch from the Sepik River floodplain. Amongst the native species, Ariidae and two species of gudgeon (*Oxyeleotris lineolatus* and *Ophieleotris aporos*) account for over 90% of the catch of native species. Tilapia are less important in other river systems in PNG. Eleotrids, theraponids and plotosids are the main fishes of importance to subsistence fisheries in hill stream areas.

During the 1950s and 1960s, trout (*Salmo trutta*, *S. gairdnerii* and *Salvelinus fontinalis*), tilapia (*Oreochromis mossambicus*) and carp (*Cyprinus carpio*) were introduced into the highlands, where trout and carp now form the basis of highland village fishing.

Aquaculture is practiced on a very limited level, carp continue to be used in small-scale village based subsistance aquaculture situations in the highlands. Limited stocking of trout (*Oncorhynchus mykiss*) continues in highland streams. A small commercial trout farm produces less than 20 t/annum.

9.1 Yield

Despite their relatively low yield, inland fisheries in PNG are very important. The 3 000 to 5 000 t/annum production of the Sepik River floodplain subsistence fishery represents one of the country's most important fisheries in terms of direct benefits to the population and a major source of animal protein in the diet of people of PNG.

9.2 Factors influencing yield

The majority of inland fisheries activities are still at the subsistence level in relatively remote and less developed areas. Low fishing effort, poor endemic freshwater fauna, poor or expensive means of transport, shortage of roads and poor marketing potential together with problems of fish processing and preservation are the major constraints in the inland fisheries of PNG. Yields obtained in other floodplain river fisheries can not be achieved in PNG based on the native fauna.

9.3 Forecast

Inland fisheries are important in PNG despite their low yield. Problems with the native freshwater fish fauna have stimulated many fish species introductions in the past, and two species (tilapia and carp) have produced useful feral

populations. It is intended to base future introductions on a better knowledge of the endemic species.

PHILIPPINES

1. AREA: 300 720 km^2

2. POPULATION: 62 400 000 Density: 207.5 persons/km^2

3. TOTAL CATCH: 2 311 797 t Inland fish: 612 360 t (26.4%)

4. PHYSICAL GEOGRAPHY

The Philippines, an archipelago consisting of some 7 107 islands and islets, is situated to the southeast of the Asian mainland and stretches 1 931 km from north to south and 1 207 km from east to west. Geographically it can be divided into four regions: the Luzon island in the north; Visayan archipelago in the middle; Mindanao island in the south; and Palawan island and Sulu archipelago in the southwest. There are twelve islands which have an area of more than 1 000 km^2 each, the largest being Luzon island and Mindanao island. The country is generally mountainous, dotted with many active and extinct volcanoes. Mount Apo (2 953 m) on Mindanao is the highest. Except for the central plain of Luzon island and some other coastal plains, flat land is scarce in the country and most of the coast is precipitous.

5. CLIMATE

The country has a monsoonal tropical rain forest climate, generally warm and humid for most of the year. There are three seasons: the hot, dry season from March to the end of May; the rainy season from June to the end of October and the cooler, dry season from November to the end of February. The yearly average temperature is about 27°C and the annual precipitation gradually increases from north to south ranging from about 2 000-3 000 mm or more; the highland regions usually have a rainfall of more than 4 000 mm per year. Typhoons are common during the rainy season. Heavy rain caused by typhoons frequently leads to flooding and heavy soil erosion.

6. HYDROLOGY

6.1 Rivers

A total of 1 437 different river systems are irregularly distributed throughout the country representing an area of about 31 000 ha, which is only three percent of the freshwater area of the country. The largest river basins are the Cagayan (25 649 km^2) and Mindanao (23 169 km^2).

6.2 Lakes

There are 69 recorded lakes with a total area of 200 000 ha which constitute more than 22 percent of the total freshwater area. Laguna de Bay is the largest lake in the country. It has an area of 91 136 ha, being rather shallow, mainly 1-2 m deep. Lake Lanao has an area of 34 304 ha with a mean depth of 60.3 m (maximum depth 112 m) and low shoreline development. Taal Lake with an area of 33 432 ha is the third largest lake.

6.3 Reservoirs

There are seven reservoirs, which cover a total area of 19 000 ha. These reservoirs represent about two percent of the total freshwater area and are mainly used for hydroelectric power and for irrigation. The reservoirs have been stocked with fingerlings of the tilapias, various carp species, milkfish and gobies. Aquaculture has also been introduced in some of them, primarily floating cage culture of tilapia. There is a paucity of information, however, on past and present fish yields in these reservoirs, making it difficult to make an assessment of the value/impact of stocking and aquaculture programmes. Yields from the capture fisheries are generally low (34 kg/ha/yr in Angat reservoir; 8.7 kg/ha/yr in Binga reservoir).

7. LAND AND WATER USE

Agriculture is the major activity in the Philippines. The total cultivated area is about 11 210 000 ha. More than two-thirds of the population is rural and nearly one-third of the country's population derives its livelihood, wholly or partially from occupations directly or indirectly related to the coconut. The country is one of the biggest coconut producers of the world. Sugarcane, sisal, hemp and tobacco are the other three major industrial crops. The major grain crops are rice and maize.

The freshwater resources of the country have an aggregate area of 1 227 389 ha. This comprises of 14 531 ha of freshwater fishponds, 200 000 ha of lakes, 31 000 ha of rivers, 19 000 ha of reservoirs, 106 328 ha of freshwater swamps and marshes that are being used for agriculture and some fisheries, and 856 530 ha of irrigated ricefields that provide some scope for rice-fish culture.

8. FISH YIELD/PRODUCTION

Nominal yield from inland waters of the Philippines*
(1982-91) (in tons)

1982	1983	1984	1985	1986
528 673	657 906	600 118	754 992	735 979

1987	1988	1989	1990	1991**
805 601	831 554	851 602	907 942	612 979

* Includes aquaculture production.
** FAO Fishery Statistics, 1991

Production from fish ponds:		
Brackishwater:	222 907.00 ha	267 814 t
Freshwater:	14 531.36 ha	35 816 t
Production from fishpens:	12 105.60 ha	24 379 t
Production from fish cages:	538.45 ha	20 931 t
Irrigated rice fields:	856 530.00 ha	---

9. STATE OF THE FISHERY

9.1 Yield

The country's total fish production has continued to increase in the past decade, reaching 2 503 546 t in 1990. Of this total, 907 942 t, equivalent to 36 percent came from the capture and culture fisheries in inland waters, i.e., freshwater lakes, freshwater/brackishwater fishponds. From 1985 to 1990, the average annual growth rate of inland fisheries was 3.5 percent, higher than that of marine fisheries (2.6 percent). Within the inland fisheries, aquaculture comprised about 74 percent of the total.

The production of 35 816 t from 14 531 ha of freshwater fishponds consisted mostly of tilapias (35 169 t or 98 percent of the total). Production from fishpens and fish cages in 1990 was 45 310 t, consisting mainly of milkfish, tilapia and carp.

9.2 Factors influencing yield

The increase in the country's aquaculture production could be attributed to the area expansion and the higher yields from brackishwater fishponds as a result of intensification of culture as well as improved production methods. A number of these brackishwater fishponds shifted from traditional, extensive methods to semi-intensive and intensive culture using modern technology. As a result, the national average brackishwater fishpond production has risen to 1.2 t/ha/yr from about 800 kg/ha/yr about a decade ago. The freshwater aquaculture production is mainly derived from freshwater fishponds, instead of fishpens and fish cages in Laguna de Bay, as in the early to mid-1980s. This is because of the drastic reduction in the area of pens and cages from about 34 000 in the early 1980s to just about 12 500 ha at present.

9.3 Forecast

As inland resources are limited and there is a need to conserve them ecologically, the opening up of new mangrove or coastal areas for brackishwater aquaculture has been prohibited and the lease rental fee for public lands used for fishpond purposes has recently been increased significantly. The latter move was intended to discourage the current private operators with the leasehold rights to the property but who do not have the capital to develop and/or operate the fishponds productively, from holding on to the areas when they can either be replanted to mangroves or profitably managed for aquaculture. With the full

implementation of this fisheries administrative order, it is likely that the total national fishpond area will decrease as some areas are converted back into mangrove forests and as those operators who are managing extensive fishponds give up their lease rights to their areas. On the other hand, it is also possible that the remaining areas are managed more intensively to maximize their productive potential, assuming that the current world shrimp market situation improves. Freshwater fishponds may increase in area with the increasing demand for fish, including tilapia which has acquired high consumer acceptance.

The development of inland fisheries by increasing the yield of existing production units and selectively expanding production units both in aquaclture and capture fisheries is emphasized. The fishpen/cage culture will maintain a steady increase in the lakes. It is estimated that a total of 357 000 ha of swampland and 856 530 ha of irrigated ricefields are available in the country. Impoundments in uplands, supplied with abundant water due to heavy annual rainfall, could create new areas for aquaclture development. The traditional extensive management practice has a tendency to intensify, but it will be a slow process. Although about 170 species of fish are reported from the freshwater areas of the country, only milkfish, tilapia, a small amount of carps and shrimp are cultivated. Polyculture and integrated farming might play an important role in increasing the yield as well as to diversify the economy.

SRI LANKA

1. AREA: 65 610 km^2

2. POPULATION: 16 806 000 Density: 256 persons/km^2

3. TOTAL CATCH: 198 063 t Inland fish: 23 832 t (12%)

4. PHYSICAL GEOGRAPHY

Sri Lanka is a pear-shaped island in the Indian Ocean off the southern extremity of the Indian subcontinent and only a little north of the equator. Its maximum length is 430 km from north to south and its maximum width is 225 km from east to west. The greater part of the island is low-lying and flat. A plain only slightly above sea level makes up the entire northern half of the island and continues around the coast of the southern half. The southern central part is hilly and mountainous, ranging from 914 to 2 133 m above sea level, Mount Pidurutalagala being the highest. The shores are mostly sandy beaches, normally subject to breakers.

5. CLIMATE

The country has a generally uniform tropical climate, which can be further separated into a tropical prairie climate in the north and a tropical rain forest climate in the south. There are no well-defined seasons and the temperature averages 27°C with little daily or seasonal variations. The average annual rainfall ranges from about 1 270 mm in the northeast section to about 5 080 mm in the southwest. The heaviest rains occur both during the south-west monsoon (May to September) and the north-east monsoon (September to January), but all-day rains are exceptional.

6. HYDROLOGY

6.1 Rivers

The island has 103 river basins, the major rivers having a combined length of about 4 500 km. These rivers discharge some 5×10^{10} m^3 (50 km^3) of water into the sea each year. Most rivers that originate in the central hill country are perennial, whereas a few dry zone rivers dry up completely during periods of drought. The Mahaweli (335 km) is the longest river in Sri Lanka. Many major rivers have been dammed (and sometimes diverted) to form hydropower and/or irrigation reservoirs.

6.2 Lakes

There are no natural lakes in Sri Lanka.

6.3 Reservoirs

The country has over 10 000 irrigation reservoirs with a total area of about 175 000 ha. Some of the reservoirs are fed by rivers, but majority are rain-fed from their own catchment areas. The Mahaweli irrigation system augments the supply of water to some of the old reservoirs. Most of the reservoirs were built in ancient times, and were restored during the first half of the century; many new ones have been recently constructed. In the Mahaweli System, about 22 480 ha have been added. Some of the reservoirs/tanks with an area over 1 000 ha each are: Parakrama Samudra (2 500 ha, 9.7 m maximum depth), Minneriya Tank (2 520 ha, 11.9 m), Kanthalai Tank (2 340 ha, 12.5 m), Giant Tank (2 020 ha, 3.6 m), Senanayake Samudra (7 700 ha, 33.5 m), Udawalawe (3 374 ha, 15.2 m), Unnichi Tank (1 100 ha, 7.9 m), Nachchaduva Tank (1 763 ha, 7.6 m), Nuwarawewa (1 182 ha, 7.0 m), Mahakanadarawa (1 440 ha, 5.8 m), Huruluwewa (2 100 ha, 8.4 m), Kaudulla Tank (2 506 ha, 9.1 m), Padaviya Tank (2 592 ha, 7.6 m), Iranamadu Tank (2 300 ha, 9.1 m), Vavnikulam (1 260 ha, 7.3 m), Nawakiri Aru Tank (1 104 ha, 5.8 m), Maduru Oya (6 280 ha, 21 m), Kalawewa (2 552 ha, 9.1 m), Rajangana (1 580 ha, 10.7 m), Rugam Tank (1 020 ha, 4.6 m), Kotmale (6.3 km^2, 78 m), Victoria (23.7 km^2, 102 m) and Randenigala (23.5 km^2, 90 m).

7. LAND AND WATER USE

Sri Lanka has a variety of vegetation. Up to an altitude of about 560 m in the wet low country, there are vast areas of paddy fields and large tracts of forest. The coconut palm grows profusely along the coast and in the low lying lands, rubber thrives at a higher level, and still higher the hills are covered with tea brushes along some moors and scrub jungle. To the north and the east of the central massif the vegetation is much more luxuriant. Thousands of irrigation reservoirs are scattered over the country. Sri Lanka is one of the largest producers in the world of tea, rubber and coconut, but the country is likely to remain dependent on imports for its staple food.

8. FISHERY YIELD AND PRODUCTION

Nominal yield from inland waters of Sri Lanka (1982-91)
(in tons)

1982	1983	1984	1985	1986
33 323	36 068	31 882	32 743	35 390

1987	1988	1989	1990	1991
36 465	38 012	39 720	31 265	23 832

9. STATE OF THE FISHERY

9.1 Yield

The country's inland fisheries are mainly reservoir fisheries. It was only during 1949-50 that a concerted effort was made to utilize the reservoirs with a view to increase the fish production. This effort has been intensified, especially in recent years, by stocking major reservoirs and seasonal tanks and introducing more and better craft and gear, so that the fish yield increased to about 39 720 t in 1989, 4.5 times the production in 1971. The average yield from reservoirs is about 300 kg/ha/yr. Once floodplain fishery existed in the Mahaweli river where the 121 km^2 of plains produced 413 tons of fish/year, equivalent to a yield of 34.1 kg/ha/yr. In seasonal tanks the average yield of about 890 kg/ha/yr was recorded. It has also been found that minor cyprinids such as Amblypharyngodon melettinus, Barbus dorsalis, B. chola and B. filamentosus could be differentially exploited in reservoirs by introducing a subsidiary gillnet fishery. The potential yield of minor cyprinids in reservoirs is estimated to be about 900 kg/ha/yr.

9.2 Factors influencing yield

During the first half of the century considerable progress was made in restoring the ancient irrigation system of the country and considerable expanses of water area became available for fisheries development. Since there was no indigenous species of fish of any significance to the commercial fisheries in the reservoirs, tilapia (Oreochromis mossambicus) were imported for the purpose of breeding and distributing to all parts of the island. By 1956, the introduction of O. mossambicus had proved a tremendous success and now accounts for the greater part of freshwater fish production. Recently other species such as gourami, Etroplus suratensis, O. niloticus, common carp, grass carp, bighead carp and Indian major carps have been introduced. At the same time the regulation of the Mahaweli system for irrigation has reduced the area of floodplains associated with the river, resulting in a loss of some 400 tons of fish annually. However, the loss is made good by yields expected from the new reservoirs of the Mahaweli system and the increased area of some of the old reservoirs fed by this system. The net increased fish yield is likely to be about 2 140 t.

9.3 Forecast

As there are no natural lakes and the rivers are mostly torrential in nature, the development of freshwater fisheries in the country will still depend on the full utilization of the reservoirs. More and more reservoirs will be operated as extensive culture fisheries, although the harvest follows the practice of capture fisheries mainly at a subsistence level.

Pond fish culture has been encouraged by the offer of subsidies, supply of free seed and know-how etc. Estate ponds in

the uplands are also being developed and the integrated farming of ducks/chicken/fish has been taken up and is showing promise of success. The yield through pond fish culture and integrated culture is expected to be 3 000 kg/ha. The expansion and intensification of milkfish culture will be continued. It is planned that development of culture fisheries be performed by private sector.

It is difficult to find suitable land for the construction of ponds solely for the purpose of fish culture, since the demand for land for agriculture is higher. However, vast areas of seasonal tanks can be developed for intensive fish culture. Moreover, the brackishwater areas of Sri Lanka, which consist of about 80 000 ha of estuaries and large deep lagoons, and about 40 000 ha of shallow lagoons, tidal flats and mangrove swamps might be convertible to fish farms for both crustaceans (shrimp) and finfish.

The programme for the development of inland fisheries includes intensive stocking of large reservoirs, development of aquaculture in seasonal tanks, development of pond, cage and pen culture, provision of subsidy for purchase of boats and construction of ponds, inland fishery development through fisheries co-operative societies, and welfare activities for inland fisherfolk.

THAILAND

1. AREA: 513 115 km^2

2. POPULATION: 56 474 000 Density: 110 persons/km^2

3. TOTAL CATCH: 3 065 170 t Inland fish: 270 000 t (8.8%)

4. PHYSICAL GEOGRAPHY

Thailand is situated in the centre of the Southeast Asian peninsula. The distance from the northermost point in the southern border is 1 650 km, and from east to west at the widest point is 780 km (narrowest point: 56 km). It has 2 614 km of coastline on the Gulf of Thailand and the Andaman Sea. Geographically Thailand is conveniently classified into five regions:

(i) The central region is the alluvial floodplain of the Chao Phraya river, extended by narrow valleys along the main tributaries.

(ii) The northern region, the most mountainous region, covers 75 percent of the country and the Doi Inthanon (2 576 m) is the highest peak in Thailand. It was traditionally the most heavily forested area.

(iii) The northeast region constitutes about one third of the area of the country comprising the Korat Platuau. The soil is mostly of sandy loam, highly permeable to water.

(iv) The southeast region comprises the hilly forested country southeast of Bangkok and is characterized by higher rainfall and poorer soils than the adjoining central region.

(v) The southern region or peninsula Thailand, south of latitude 11°, is sharply divided by the central mountain range into east coast and a west coast tracts.

5. CLIMATE

The north, northeast and central regions have a tropical monsoon climate with three distinct seasons: rainy-from May to October, cool-from November to February, summer-high temperatures in March and April. The monthly temperature in April may reach 40-42°C, and the winter temperature in the north and northeast can fall to 10°C or lower. The average rainfall in these regions is 1 250 mm per year, while the Korat Plateau receives less than 500 mm per year.

The south and southeast regions have a tropical rain forest climate. Rainfall occurs virtually throughout the year, the average annual rainfall reaching 3 000 mm or more along the coast. There is little variation in temperature, around an average of 28°C. March and April are normally the driest months.

6. HYDROLOGY

6.1 Rivers

There are 47 rivers and canals with a total area of about 119 200 ha. The Chao Phraya is the largest river system of the country. It is formed by 4 large tributaries flowing southwards, namely the Ping, Wang, Yom and Nan rivers. The Chao Phraya originates at the junction of the rivers Ping and Nan about 200 km northwest of Bangkok and then runs for 350 km down to the mouth. The Ta Chin, Pasak and Lopburi are the main tributaries in the central plain. There is, at the lower reaches of the river, a dense network of canals. The river has a maximum discharge of 3 400 m^3/sec and an overall length of 1 200 km. In total, the main rivers exceed 20 000 km in length and there is more than 18 000 km^2 of floodplains which serve as important spawning areas for fish.

The Mekong river in the northeast forms about 800 km of the boundary with Laos, and is rich in fish resources. The Chi and Mun are other major rivers in this region. The Tapi is the largest river of the southern region. The Bangpakong, Rayong, Weru, Pra-Sae and Chantaburi are major rivers in the eastern region.

6.2 Lakes

A total of 300 000 ha of lakes exist. The Songkhla Lake in the south, is the largest freshwater area; it is actually a large lagoon in the southern peninsula. It has five principle subsections making a total area of 104 000 ha. The lakes are all very shallow and swampy, about 1-2 m in depth and flat bottomed. They are subject to tidal inflows so that the lower half is brackish while the upper half is fresh. Their salinity varies from 2.5-21.5‰; it also varies greatly according to the rainfall intensity and direction of water flow. The Bung Borapet is a large swamp of about 20 000 ha in the central plain. Nong Han lake (7 500 ha) in the northeast and Kwan Phayao lake (1 700 ha) in the north, have substantial fish resources.

6.3 Reservoirs

In the past three decades, 20 multipurpose reservoirs ranging in size from 1 200 to 41 000 ha have been built in Thailand. The total area of these reservoirs is 285 272 ha. Most of these reservoirs are shallow with a mean depth less than 10 m. The largest reservoirs are Ubolratana (41 000 ha, mean depth 6.2 m), Srinakarin (40 000 ha, mean depth 42 m), Sirinthorn (29 200 ha, mean depth 5.1 m), Sirikit (28 480 ha, mean depth

36.7 m), Lam Pao (23 000 ha, mean depth 5.5 m) and Bhumipol (20 400 ha, mean depth 44.7 m). There are, in addtion, 2 000 small impoundments or tanks less than 1 000 ha each, having an area of 25 000 ha altogether.

7. LAND AND WATER USE

Agriculture, including forestry and fisheries, employs some two-thirds of the population in Thailand. Some 102 000 km^2 of land, representing 20 percent of the country area, are cultivated and some 180 000 km^2 are covered by forests. The country is self-sufficient in food, producing 23.04 million tons of crops in 1990. The Chao Phraya Central Plain has the best rice growing fields. Thailand is the world's largest exporter of rice, and second of rubber and fifth of sugar and cassava, and is one of the world's largest producers of teak.

An area of 5 500 000 ha of freshwater constitutes more than 10 percent of the country area, including reservoirs, lakes, rivers, swamps and fishponds, in addition to 18 000 km^2 of flood area and 31 000 km^2 of irrigated rice fields.

8. FISHERY YIELD/PRODUCTION

Nominal yield from inland waters of Thailand (1982-91)*
(in tons)

1982	1983	1984	1985	1986
133 562	155 447	161 819	167 453	188 063
1987	**1988**	**1989**	**1990**	**1991**
177 162	196 757	215 930	230 966	270 000

* Includes aquaculture production.

9. STATE OF THE FISHERY

9.1 Yield

Capture fisheries conducted in natural water bodies amounts for more than 60 percent of the total freshwater production. It is made up of yields from large impoundments (25%), small impoundments (10%), rivers (25%), swamps and ditches (15%) and rice fields (25%). In large impoundments fisheries are mostly commercial, whereas in other areas they are mostly part-time. The main species and their general distribution are:

snakehead	10 percent
catfish	6 percent
Asian barb	20 percent
others	64 percent

The estimated yield is:

floodplains	125 kg/ha
impoundments	60-90 kg/ha
lakes	160-200 kg/ha
rice fields	30-50 kg/ha

In 1988, 52 238 ha of fish culture area produced 102 128 tons. While 50.08 percent was from fishponds, 49.36 percent was from paddy fields, 0.01 percent from cages and 0.55 percent from ditches. The main species cultured are Trichogaster, tilapia, Puntius, Ophicephalus, Oxyeleotris, Pangasius, Clarias, carps and prawn (Macrobrachium).

9.2 Factors influencing yield

Inland fisheries are principally concentrated in the Chao Phraya river and the flood area of the central plain. The central plain is flooded every year and serves as an important spawning ground for the fish and produces more than 70 percent of the total production of the inland water. The irrigation projects in the north have reduced the fishery production of these areas. Floodplains produced 40 000 t of fish in the past years but their production fell to 10 000 t in recent years. Although the water area of reservoirs has been increased, the production in these areas declined from 18 000 to 15 000 t. Aquaculture has expanded rapidly in recent years. Production increased from about 108 335 t in 1984 to about 538 959 t in 1990. Due to large demand and high prices, the shrimp and giant prawn culture has developed quickly in the country, an estimated 97 330 t shrimp being produced in 1990. The significant achievement in mass production of giant prawn fry can ensure an adequate supply of the postlarvae and juveniles.

9.3 Forecast

The production of inland waters increased gradually from 40 850 t in 1947 and reached its highest point in 1975 (160 700 t). It is recognized that the resources in the natural water bodies are declining at present. The tendency to regulate the flow of rivers in the interest of agriculture and industry may have some further adverse effects on the highly productive floodplain fisheries. So an extensive artificial propagation programme has been launched, which might reach its goal in the long run. Perhaps the wild areas of swamps and shallow lakes could produce as much as 500-1 200 kg/ha, the catch from reservoirs could be increased from 15 000 t to 25 000 t, and the production of small tanks could be doubled by proper management and stocking. Aquaclture, both inland and brackish, will continue to expand and an increase in production of especially shrimps and prawns can be expected.

VIET NAM

1. AREA: 331 700 km^2

2. POPULATION: 68 082 000 (1991) Density: 205.2 persons/km^2

3. TOTAL CATCH: 877 000 t* Inland fish: 267 000 t* (30.4%)

* FAO Fishery Statistics, 1991

4. PHYSICAL GEOGRAPHY

Viet Nam is situated in Southeast Asia and it has a north to south extension of about 1 650 km. The maximum east to west extension is about 600 km. Most of northern Viet Nam is mountainous or hilly, but lowlands prevail in the Red River Delta and the coastal plains that extend northeast and south from the delta. The southern part is dominated by the estuary of the Mekong River system, making the country low, flat and frequently marshy. The country is divided into three distinct geographic areas: (a) the plains which extend throughout the length of the country, with the Red River Delta in the north and the Mekong Delta in the south being the dominant parts, (b) the highlands, consisting of the mountain ranges in the northwest which continue southwards to the center of Viet Nam, and (c) the sea coast which is 3 260 km long.

5. CLIMATE

The climate of the country is monsoonal in character, ranging from tropical in the south to sub-tropical with a cool winter in the north. Average annual rainfall varies from 1 500 to 2 000 mm, except for the central highlands which have 2 500 to 3 000 mm. The north has a monsoon climate with a hot, wet season from mid-May to mid-September (southwest monsoon) with heavy rain and typhoons, which results in much of the delta region being seasonally flooded. From mid-October to mid-March (northeast monsoon), a relatively warm, humid dry season prevails, with relatively low temperatures (average 16°C), low rainfall and two short transitional seasons. Hanoi has a mean annual rainfall of 1 730 mm. The climate of southern Viet Nam is tropical, with constant high temperatures between 25°C and 30°C. The annual rainfall in the Ho Chi Minh City is about 2 000 mm.

6. HYDROGRAPHY

6.1 Rivers

There are 15 major river basins in the country, each with a catchment area in excess of 3 000 km^2. The two major river

systems in Viet Nam are the Hong (Red) River in northern Viet Nam and the Mekong River in the south. Both rivers are characterized by extremely low discharge rates during dry season and high flood discharge during the monsoon. The Hong (Red) River originates in the centre of the province of Yunnan in southwest China; it flows south-east across northern Viet Nam, past Hanoi and empties into the Gulf of Tonkin. It has a length of more than 400 km and has a wide fertile delta east of Hanoi. The Mekong River enters Viet Nam from Cambodia and continues south through southern Viet Nam for about 200 km and empties into the South China Sea through several mouths and a low, flat and frequently marshy delta. Other smaller rivers with lengths between 200 and 400 km in Viet Nam, from north to south are the Gam River, Lo River, Da River, Ma River, Ca River and the Dung River.

6.2 Lakes

There are no large lakes in the country, but there are numerous smaller bodies of water associated with the river system in the deltas and some small lakes scattered to the south of the highland terrain of the central region.

6.3 Reservoirs

A total of 397 500 ha of medium and large reservoirs exist in Viet Nam. The Thae Ba reservoir northwest of Hanoi is the largest, with an area of about 24 000 ha. FAO is presently carrying out a Technical Cooperation Programme project that involves aquaculture training and rehabilitation of reservoir fishery in the 2 500 ha Nui Coc reservoir in the province of Bac Thai, northern Viet Nam.

7. LAND AND WATER USE

The country can be divided into seven agro-ecological zones, differentiated on the basis of climate, physical environment, land-use and agriculture characteristics. Of the total area of 33 million ha, about 55 percent is in productive use, either for agriculture (6.94 million ha) or under forest. The Mekong Delta accounts for some 38 percent of the country's cultivated area and food production, and the Hong (Red) River Delta accounts for 18 percent of the food production with 13 percent of cultivated area. Much of the delta region is seasonally flooded, and a complex network of dikes and levees throughout this area prevents serious flood damage.

Paddy is the traditional food crop and constitutes 87 percent of total food crop production. Other important food and industrial crops are maize, root crops, rubber, coffee, tea, coconut, sugar-cane, cotton, groundnuts and soybean. Current forest cover is estimated at 7.8 million ha, of which 74 percent is closed evergreen forest, 20 percent bamboo, 4 percent is mangrove, and 2 percent is pine. Overall forestry resources are severely depleted due to the combined effects of war, widespread selective logging, fuelwood collection, wildfires and the spread

of shifting cultivation resulting from rapid population growth and the scarcity of agricultural lands. The present reforestation rate is about 100 000 ha per annum.

The country has about 1.4 million ha of inland waters suitable for aquaculture, of which 548 050 ha (39.8 percent) are paddy fields; 397 500 ha (28.7 percent) of medium and large reservoirs; 290 200 ha (21.1 percent) of tidal flats; 84 700 ha (6.2 percent) of lagoons and bays and 58 088 ha (4.1 percent) of small lakes and ponds. One third of the available water surface (530 000 ha) is already being used for aquaculture purposes, with 325 000 ha (61 percent) being used for fish culture, of which more than 90 percent is under pond fish culture, the rest under rice-cum-fish culture.

Cage fish culture was only introduced a few years ago, but some 5 000 cages have been constructed and operated in a few reservoirs along the Mekong, Red and Duong Rivers, producing about 1 000 t fish annually.

8. FISHERY YIELD/PRODUCTION

Nominal yield from inland waters of Viet Nam (1982-91)*
(in tons)

1982	1983	1984	1985	1986
188 600	204 530	228 279	236 150	248 666

1987	1988 **	1989 **	1990 **	1991 **
259 600	258 000	258 000	247 000	267 000

* Includes aquaculture production.
** FAO Fishery Statistics, 1991

9. STATE OF THE FISHERY

9.1 Yield

The major inland fisheries production areas in Viet Nam are the two deltas, i.e. the Red River Delta that includes the Thai Binh River system and the Mekong River Delta that includes the Dong Nai River system. A great part of the fish produced through aquaculture in the Red River Delta area is from small size family ponds. Production from these ponds vary from a few hundred kg/ha in extensive culture ponds to over 1.5 t/ha in semi-intensive systems in the VAC system (a farming system that integrates horticulture, fish culture and animal husbandry on a household basis). Sixty-five percent of the fish seed of Chinese and Indian carps produced in Viet Nam is from the Red River Delta area. In the Mekong River Delta area, both freshwater fish culture and brackishwater shrimp culture is practiced. The area under freshwater fish culture is 51 693 ha, producing 102 000 t of fish, 126 000 ha are utilized for shrimp culture, producing

39 000 t of shrimp. Of the 324 860 ha of paddy fields in this area, only 35 000 ha are utilized for rice-cum-fish culture, producing about 6 000 t of fish annually.

The fish fauna in Viet Nam consist of about 500 species, of which 35 species are economically significant at present. The main culture species are the Chinese carps (grass carp, silver carp, bighead), Indian major carps (catla, rohu, mrigal), common carp, Pangasius, catfishes (Clarias spp), snakeheads, barbs and tilapias (Oreochromis niloticus and O. mossambicus).

9.2 Factors influencing yield

Fisheries in Viet Nam is highly diversified, including inland and marine capture fisheries, as well as freshwater and brackishwater aquaculture. The share of inland fisheries and aquaculture is 28.2 percent of the total fisheries production. There are 375 freshwater hatcheries, producing about 6 billion of larvae, fry and fingerlings of various cultured species annually. Survival rate however is low, due to poor genetic strains of brood stock, outdated facilities, poor management practices during the nursery stage and the lack of funds. As a result, most operate at or below 50 percent design capacity. As a result of the conversion of one third (100 000 ha) of the mangrove areas into shrimp ponds along the Mekong tidal flats, fishery resources harvested in the delta region have decreased sharply, with annual catch of the Mekong fish species now down to 100 000 t. However, aquaculture has somewhat compensated for and contributed to the inland fisheries production, and the optimal utilization of land and water resources under the VAC integrated farm system has shown good results in increasing productivity, employment, income as well as improving the nutritional standards of rural farming households.

9.3 Forecast

Viet Nam is heavily dependent upon its fisheries resources for animal protein which supply 35 percent of Viet Nam's total animal protein intake. Approximately 70 percent of the fisheries production is consumed domestically, equalling about 10.5 kg per capita. The country has 1.4 million ha of inland waters suitable for aquaculture. A total of 1.2 million people are employed in the fisheries sector, and of this,approximately 260 000 (26 percent) are involved in aquaculture activities. To be able to exploit and utilize the available land and water resources, apart from the application of more intensive culture methods, the VAC integrated farm system has the potential to substantially increase the inland fisheries production and elevate the socio-economic status of the rural areas of the country.

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